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SHRUB PLANTINGS FOR EROSION CONTROL IN EASTERN WASHINGTON--PROGRESS AND RESEARCH NEEDS

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ABSTRACT

In August 1975, survival measurements and vigor estimates were made on 14 species of shrubs planted on road cut and fill slopes between 1971 and 1973 on the Wenatchee, Okanogan, and Colville National Forests. Their average survival ranged from 37 to 53 percent and was better at low than high elevations and greater on fill slopes than cut slopes.

Of species planted on enough sites to enable a good assessment of survival, blue elderberry, bush penstemon, wild rose, and serviceberry had the highest survival. Vigor of blue elderberry and penstemon was good, but vigor of wild rose and serviceberry was only fair to poor.

Survival rate of bitterbrush, squaw carpet ceanothus, and snowbrush ceanothus was reduced on cut slopes because plants were covered by ravelling soil material. However, good survival and growth of these plants on fill slopes indicate they can probably be used successfully on many sites of this type.

KEYWORDS: Erosion control -)vegetal cover, vegetation types, shrubs, native plants.

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Natural revegetation of road construction cuts and fills and other severely disturbed wildland sites in the Pacific Northwest is often a slow process. Highly disturbed areas without vegetative cover have low esthetic value and are susceptible to erosion. Seeding of disturbed areas with grasses and legumes to provide protective vegetative cover has been recommended in the Pacific Northwest by Dyrness (1967, 1970) and Klock et al. (1975). However, soil and microclimatic conditions of many planting sites in the interior Pacific Northwest limit the use of common grasses and legumes. Disturbed sites are characterized by loose, droughty soils depauperate in plant nutrients. They are also characterized by extremes of soil and air temperatures and frequent soil movement resulting from frost action and dry rattle. Shrubs have been shown to stabilize such arid and harsh areas (Horton 1949, Plummer 1974, McArthur et al. 1974, McKell 1975).

In 1970 the Coeur d'Alene Forest Nursery in Idaho initiated a program for growing and test planting native shrubs to stabilize and beautify road cuts and fills and other disturbed wildland sites in the Pacific Northwest. Shrubs from the nursery have been used since 1971 for planting trials on the Wenatchee, Okanogan, and Colville National Forests in the State of Washington.

We evaluated these initial plantings to make an early assessment of species that can be used operationally, to recommend planting techniques, and to determine immediate research needs.

METHODS

In October 1973, 1-year-old, bare-root shrub seedlings from the Coeur d'Alene Nursery were planted on newly constructed road cutbanks and fills in the Entiat Experimental Forest and adjacent Wenatchee National Forest lands in the Entiat Valley. Six to ten species were planted in 4 to 10 blocks at 12 locations. Within blocks, five to seven plants of an individual species were planted in a single row spaced at 1 meter between plants and adjacent rows. The seedlings were planted with a hoedag or flat spade from a 6-meter aluminum extension ladder laid upslope. The ladder gave the planter quick and easy access for planting two rows and kept site disturbance during the planting operation to a minimum. The soils on sites 1 and 2 were colluvium subsoil derived predominantly from granodiorite parent material. The other 10 plantings were in decomposed granodiorite, volcanic ash, highly unstable "popcorn" pumice, or mixtures thereof. Organic matter and plant nutrient content were extremely low on all sites. Slope steepness ranged from 40 to more than 70 percent. Good soil moisture conditions prevailed at all locations at planting time. Species planted were:

Wenatchee National Forest	Growth habit[3]
Oregongrape (*Berberis repens* Lindl.)[4]	Low, trailing shrub usually less than 1 m tall.
Bush penstemon (*Penstemon fruticosus* (Pursh) Greene)	Ascending or erect, bushy branched shrub or subshrub, 0.5 to 1 m tall; spreads laterally by layering and may form mats to 1 m in diameter.
Squaw carpet ceanothus (*Ceanothus prostratus* Benth.)	Prostrate or matlike shrub, 1 to 3 m across; roots by layering.
Snowbrush ceanothus (*Ceanothus velutinus* Dougl.)	Compact shrub, 1 to 2 m tall, evergreen, symbiotic nitrogen fixer, susceptible to winter dieback on exposed sites.
Sedgeleaf buckbrush (*Ceanothus cuneatus* (Hook.) T. & G.)	Rigid, many-branched evergreen shrub, 1 to 4 m tall.
Redstem ceanothus (*Ceanothus sanguineus* Pursh)	Erect, open shrub, 1 to 2 m tall.
Serviceberry (*Amelanchier alnifolia* Nutt.)	Erect, many-stemmed shrub or small tree, 1 to 6 m tall.
Bitterbrush (*Purshia tridentata* (Pursh) DC.)	Diffusely branched, semierect shrub, 0.3 to 2 m tall.
Blue elderberry (*Sambucus cerulea* Raf.)	Coarse, many-stemmed shrub or small tree, 1 to 6 m tall.
Snowberry (*Symphoricarpos* sp.)	Erect shrub, 0.6 to 1.2 m tall, spreads by rhizomes.

The seed sources for these shrubs were not from the local planting area; but with the exception of squaw carpet ceanothus and sedgeleaf buckbrush, all species can be found in the Entiat Valley. No chemical fertilizer amendments were used on any of the plantings.

Bare-root shrubs from the Coeur d'Alene Nursery were planted in the fall on road construction cut slopes on the Colville National Forest in

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[3] From U.S. Department of Agriculture (1937), Hayes and Garrison (1960), Hitchcock et al. (1955-69).

[4] Plant nomenclature follows Hitchcock and Cronquist (1973).

1971 and 1973 and on the Okanogan National Forest in 1973. Nine locations on each Forest were chosen for evaluation. Species planted were:

Colville National Forest	Growth habit
Serviceberry	
Bitterbrush	
Wild rose (*Rosa* sp.)	Spreading shrubs 1 to 2 m tall, sprouts from shallow subsurface root system and forms dense thickets.
Curl-leaf mountain mahogany (*Cercocarpus ledifolius* Nutt.)	Shrub or small tree 0.3 to 4 m tall.
Snowberry	
Smooth sumac (*Rhus glabra* L.)	Many-stemmed shrub, 1 to 3 m tall, spreads by elongate, shallow roots and forms dense thickets.

Okanogan National Forest	Growth habit
Oregongrape	
Bush penstemon	
Bitterbrush	
Wild rose	
Curl-leaf mountain mahogany	
Chokecherry (*Prunus virginiana* L.)	Erect shrub or small tree, 1 to 10 m tall.
Kinnikinnick (*Arctostaphylos uva-ursi* (L.) Spreng.)	Low, prostrate evergreen, often forming mats to 2 m in diameter.

With the exception of curl-leaf mountain mahogany, these shrubs were grown from seed collected in the general area of the plantings. Curl-leaf mountain mahogany is found principally from southeastern Washington to California.

In August 1975 we evaluated survival and vigor of all plantings. Vigor was based on size of plant and color of foliage and was classed as good, fair, or poor. Complete records of survival were kept on the Wenatchee National Forest plantings. The Colville and Okanogan National Forest plantings were established without a complete record of the number of plants of each species planted at each location. Therefore, some reconstruction of plant spacing was necessary for estimating survival. In some cases,

survival data are estimates made by the individual who supervised the plantings.

RESULTS AND DISCUSSION

Survival data from the planting trials reveal several shrub species with potential for use in disturbed area revegetation programs in the interior Pacific Northwest.

WENATCHEE NATIONAL FOREST SITES

The broad array of conditions on the Wenatchee National Forest enabled us to assess survival of shrubs planted there as a function of aspect, elevation, and type of sites (road cut or fill). After 2 years survival of all species on all sites on the Wenatchee National Forest averaged 38 percent. Elevation (range 755- to 1 478-m) appeared to have little effect on total survival. Slightly higher survival was observed on southerly and easterly aspects than on westerly aspects. No plantings were made on north aspects. The greatest site difference for survival was between road cuts (33 percent) and road fills (55 percent). Differences in depth, texture, stability, and moisture-holding capacity of the soil material between the cuts and fills probably account for this difference.

Average survival of individual species on the Wenatchee National Forest ranged from 13 percent for bitterbrush to 75 percent for blue elderberry (table 1).

Survival of blue elderberry was consistently high (62 to 87 percent), and this species displayed good vigor on all locations. Its tough stems along with its rapid growth rate provided an important advantage on unstable, "popcorn" pumice road cuts. We were especially pleased with elderberry survival and growth since the 1-year-old seedlings we planted were quite large, and we had to severely prune the root systems on many plants to facilitate planting.

Bush penstemon survival was 40 percent or greater at all sites except 5 and 9, where many plants were buried by pumice. Vigor of the surviving plants was good, and this species should show a positive response to fertilization (Klock 1976).

Survival of Oregongrape was low and vigor fair to poor. Survival of bitterbrush, snowbrush ceanothus, squaw carpet ceanothus, and sedgeleaf buckbrush was generally low. However, surviving plants of these species had good vigor on most sites. Soil often covered these species on cut slopes because frost action or wetting and drying caused the soil to move (fig. 1). Partial or complete burial of plants coupled with plant characteristics such as small size, lateral growth habits, and slow growth rates appear to be the principal reasons for low survival of these species. The higher survival rates observed on fill slopes, where there was less evidence of soil movement than on cut slopes, support this conclusion.

Although elevation appeared to have little influence on average survival of all species, bitterbrush survival did appear to be affected by elevation of planting site. On fill slopes where survival is not complicated by soil movement, survival declined progressively from 50 to 36 to

Table 1--*Percent of survival 2 years after planting of bare-root shrubs on road cut and fill slopes, Entiat District of the Wenatchee National Forest*

Variable				Oregongrape	Bush penstemon	Squaw carpet ceanothus	Snowbrush ceanothus	Sedgeleaf buckbrush	Redstem ceanothus	Serviceberry	Bitterbrush	Blue elderberry	Snowberry
Site	Elevation	Aspect	Type of slope										
	Meters												
1	755	SE	Fill	--	45	--	25	30	37	--	50	62	--
2	792	SE	Cut	4	58	0	4	2	40	50	0	77	73
3	792	SE	Cut	9	47	33	24	--	--	58	13	87	--
4	914	SE	Cut	40	71	20	37	--	--	71	9	76	--
5	945	SE	Cut	0	20	0	7	--	--	60	0	67	--
6	1 098	E	Cut	3	46	6	20	--	--	22	11	80	--
7	1 098	E	Fill	60	86	48	74	--	--	86	36	78	--
8	1 158	W	Cut	7	49	11	42	--	--	80	9	77	--
9	1 216	SE	Cut	29	40	23	26	--	--	69	17	70	--
10	1 251	SE	Cut	27	53	20	27	--	--	40	13	--	--
11	1 463	W	Cut	13	37	10	23	--	--	77	0	--	--
12	1 478	S	Fill	54	80	37	74	--	--	88	3	--	--
Average survival[1/]				22	53	19	32	16	38	64	13	75	73

[1/] Average survival of all species on all sites was 38.

Figure 1.--Planted shrubs on a ravelling pumice cut slope of the Entiat Experimental Forest.

3 percent as elevation increased from 755 to 1 098 and to 1 478 m, respectively. This response to elevation by bitterbrush could be expected since it is a component of the ponderosa pine (*Pinus ponderosa* Dougl.)/bitterbrush/bluebunch wheatgrass (*Agropyron spicatum* (Pursh) Scribn. & Sm.) habitat type generally found below 900 m in the Entiat Valley. Thus, seven of the planting locations were above the normal elevational range for bitterbrush. Also, the vigor and growth rate of both blue elderberry and serviceberry appeared to decline above 1 200 m. This response may result from either a shortened growing season because plants are covered by snow for a longer period or because we exceeded the elevational tolerances of these species.

For species with good survival rates but only planted on one or two sites, more plantings are needed before use can be recommended. Survival of snowberry on the one site planted was 73 percent and of redstem ceanothus 37 and 40 percent on the two sites planted.

OKANOGAN AND COLVILLE NATIONAL FOREST SITES

Average survival of all shrubs in the Okanogan and Colville National Forest plantings were 37 and 53 percent, respectively (tables 2 and 3). However, survival data from these evaluations must be interpreted with caution--the number of species planted at each location and the number of plantings of each species vary considerably.

Wild rose was planted at 14 locations on the two Forests and had one of the best survival rates of the species tested. There appeared to be little effect from elevation although the lowest survival was observed on two plantings at lower elevations on the Colville. Vigor of wild rose at most sites was fair to poor. Lower leaves on many plants appeared chlorotic, possibly indicating a higher nutrient requirement than some of the other shrub species.

Curl-leaf mountain mahogany was planted only on three midelevation sites on the two Forests. Average survival was about 42 percent, and vigor was good.

Table 2--*Percent of survival of bare-root shrubs planted on road cut slopes of the Colville National Forest*

Variable			Serviceberry	Bitterbrush	Wild rose	Curl-leaf mountain mahogany	Snowberry	Smooth sumac
Site	Elevation	Aspect						
	Meters							
1	853	N	--	--	22	--	80	--
2	853	SE	--	--	[2/]80	--	--	--
3	884	SW	--	--	[2/]50	--	22	--
4	914	S	--	50	--	40	--	--
5	914	S	--	[2/]--	10	--	0	--
6	914	SE	--	[2/]50	--	--	--	--
7	945	SE	--	--	[2/]90	--	--	--
8	975	E	85	--	--	40	--	52
9	1 005	SE	85	--	85	--	--	--
Average survival[1/]			85	50	56	40	34	52

[1/] Average survival of all species on all sites was 53.

[2/] Estimated by individual responsible for plantings.

Table 3--*Percent of survival of bare-root shrubs planted on road cut slopes of the Okanogan National Forest*

Variable			Oregongrape	Bush penstemon	Snowbrush ceanothus	Bitterbrush	Wild rose	Curl-leaf mountain mahogany	Chokecherry	Kinnikinnick
Site	Elevation	Aspect								
	Meters									
1	853	S	22	62	--	67	54	--	42	--
2	975	NW	--	--	--	--	71	--	--	--
3	1 036	SE	[2/]--	--	--	[2/]--	[2/]70	--	--	--
4	1 127	SE	[2/]15	--	--	[2/]35	[2/]30	--	--	--
5	1 158	SE	14	[2/]50	--	0	[2/]50	[2/]45	--	0
6	1 310	S	--	0	0	0	--	--	--	--
7	1 341	W	--	[2/]--	--	31	[2/]70	--	[2/]--	--
8	1 371	S	--	[2/]40	0	--	[2/]80	--	[2/]35	--
9	1 463	S	45	--	34	--	85	--	--	--
Average survival[1/]			24	38	11	27	63	45	39	0

[1/] Average survival of all species on all sites was 37.

[2/] Estimated by individual responsible for plantings.

Some of all the remaining six species planted on the Okanogan National Forest survived except the one planting of kinnikinnick (table 3). Bush penstemon survival was 40 percent or greater on three of the four sites where it was planted. However, on the fourth site (site 6), no shrubs of any species survived, indicating there may be other reasons for mortality at this particular location than a low inherent survival potential of the plants. The vigor of the surviving bush penstemon was generally fair to good. Bitterbrush survival on the Okanogan National Forest was high at the lowest elevation site (67 percent), and vigor was good. At sites above 1 127 m, survival was poor and vigor of plants fair. Survival of snowbrush ceanothus and Oregongrape varied but was generally poor, and vigor was fair to poor on all sites. Chokecherry survival was 35 and 42 percent, but vigor of plants was only fair.

Serviceberry, bitterbrush, snowberry, and smooth sumac showed some survival in the Colville trials (table 2). The elevational range of these plantings was too narrow to enable us to evaluate survival differences in response to elevation. Serviceberry survival was 85 percent on both sites planted. However, most plants were small and appeared to be growing very slowly. Vigor was rated only fair. Smooth sumac was planted at only one location and bitterbrush at two, but survival and vigor of both species were good. Snowberry appears to be sensitive to aspect--survival varied from 0 to 22 percent on southerly aspects compared with 80 percent on a north aspect. Vigor of surviving plants was poor.

In the range between 850 and 1 200 m, elevation generally appeared to have minimum influence on the species tested. Below this range, species such as bitterbrush would most likely be more suitable. Above 1 200 m some species not tested in our trials such as willows (*Salix* sp.) and Sitka alder (*Alnus sinuata* (Reg.) Rydb.) may exhibit greater survival.

Seedling size is very important. The stem portion must be tall enough to withstand inundation by ravelling, loose, soil material; but the root system must be small enough to allow hand planting with minimum site disturbance. Use of containerized seedlings may overcome the planting difficulty encountered when large field-grown seedlings are used.

Another possible factor affecting our shrub seedling survival was wildlife. South-facing road cuts are some of the first sites to be free of snow in the spring. Small young shrubs are very attractive to browsing animals. We observed a striking loss of snowbrush ceanothus seedlings to deer during the first spring after planting on the Wenatchee National Forest.

RECOMMENDATIONS

Despite an obvious need for additional testing, several species evaluated in this study can be recommended for operational use. Blue elderberry and bush penstemon appear suited to a wide variety of sites. Vigor of wild rose and serviceberry was not as good as blue elderberry and bush penstemon, but both species exhibited good survival on most sites tested. Supplementary fertilization may enhance the effectiveness of these two species. Bitterbrush can be recommended for use on sites at lower elevations--probably below 1 100 m. On sites with severe soil ravelling or road cut slopes, plantings of squaw carpet ceanothus and snowbrush ceanothus should probably be restricted to fill slopes. Oregongrape, although a common plant in eastern Washington, was

unsatisfactory in these trials. Most of the other species examined were not tested on enough sites to indicate their suitability for operational use.

In future operational plantings, we suggest careful recordkeeping of planting procedures and locations for subsequent use in evaluating species performance. Information from such plantings will aid the nurseryman and land manager in determining which species (and geographic sources of each) will have the best chance of survival at particular locations.

A seed source close to the intended area of planting (for seedling production by the nursery) is also likely to improve revegetation success. Thus, the development of an effective, operational shrub planting program is a long-term effort.

Care of bare-root planting stock is also a critical factor in survival. Only dormant plants should be planted. Planting crews should take to the field only the number of plants that can be planted in 1 day. Excess stock should be returned to cold storage and planted first the next day. Seedlings should be planted only in moist soil, never under droughty conditions.

Considerable research is needed to develop sufficient information for complete shrub planting prescriptions on severely disturbed lands in the interior Pacific Northwest. Immediate research should emphasize: characterization of growth form, growth rate, and physiological requirements and tolerances of shrubs; relation of plant requirements to soil and site factors found on severely disturbed sites; increased knowledge of the effect of fertilizers on survival and growth in nursery and field plantings; determination of best planting season; and effect of physical controls such as contour trenching on survival and growth of shrubs.

From our limited experience, we predict shrub plantings will be a useful practice along with other soil conservation measures to help the land manager protect wildland soil and water resources in the interior Pacific Northwest.

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